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Abstract

BEHAVIOUR OF URANIUM UNDER IRRADIATION

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The main results obtained in a study of the formation of defects caused in uranium by fission at low temperature are reported. By irradiation at 20°K it was possible to determine the number of Frenkel pairs produced by one fission. An analysis of the curves giving the variations in electrical resistivity shows the size of the displacement spikes and the mechanism of defect creation due to fission. Irradiations at 77°K gave additional information, showing behaviour differences in the case of recrystallised and of cold worked uranium.

The diffusion of rare gases was studied using metal-rare gas alloys obtained by electrical discharge, and samples of irradiated uranium. Simple diffusion is only responsible for the release of the rare gases under vacuum in cases where the rare gas content is very low (very slightly irradiated U). On the other hand when the concentration is higher (samples prepared by electrical discharge) the gas is given off by the formation, growth and coalescence of bubbles ; the apparent diffusion coefficient is then quite different from the true coefficient and cannot be used in calculations on swelling.

The various factors governing the phenomenon of simple diffusion were examined. It was shown in particular that a small addition of molybdenum could reduce the diffusion coefficient by a factor of 100.

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The precipitation of gas in uranium (Kr), in silver (Kr) and in Al-Li alloy (He) have been followed by measurement of the crystal parameter and of the electrical resistivity, and by electron microscope examination of thin films. The important part played by dislocations in the generation and growth of bubbles has been demonstrated, and it has been shown also that precipitation of bubbles on the dislocation lattice could block the development of recrystallisation.

The results of these studies were compared with observations made on the swelling of uranium and uranium alloys U Mo and U Nb strongly irradiated between 400 and 700°C.

In the case of Cubic phase alloys (U Nb, U Mo) the size and distribution of the bubbles are greatly influenced by the existance of a polygonisation lattice, formed before irradiation, inside the grains. During high temperature annealings the bubbles situated on the polygonisation lattice grow much faster than those which are distributed inside the crystal.

In the case of uranium the bubbles are either distributed at random, or grouped in flat accumulations which can give rise to transgranular cracks, according to the state of the metal and the irradiation temperature. At high temperature an intergranular decohesion is also observed.